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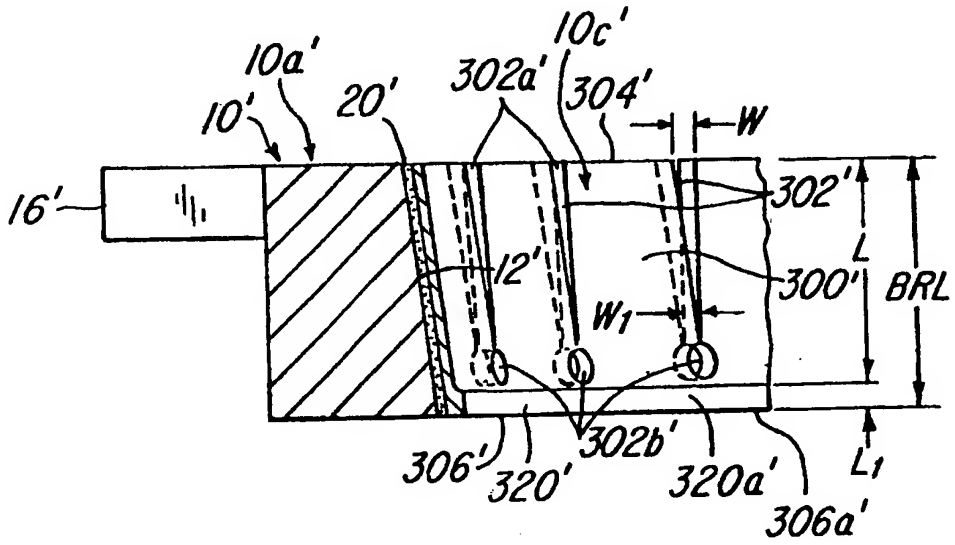

(57) Abstract

A friction lining (300') having slots (302') extending from one edge (304') to a rib (320') adjacent the other edge (306'), is bonded (e.g. with adhesive) to a frusto-conical surface of a friction ring (10') (e.g. of metal) so that the open ends (302a') of the slots (302') are wider than the closed ends (302b').

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FRICTION LINING MOUNTED ON FRICTION RING

Cross-Reference to Related Application

This application is a continuation-in-part of co-pending Serial No. 08/794,178 filed February 3, 1997 which is a continuation of Serial No. 08/316,204 filed September 30, 1994 now U.S. Patent 5,615,758.

Background of the Invention

1. Field of the Invention

The present invention relates to a fabric arrangement and method for controlling fluid flow and, more particularly, to a fabric arrangement and method for controlling fluid flow which may be utilized with friction elements. In one embodiment, the invention provides a method and system for forming a frictional material having a plurality of slots with an optional chamfer and/or raised rib.

2. Description of Related Art

In clutches, brakes, automatic transmissions, limited slip differentials, hoists and similar friction power transmission and energy absorption devices, there is generally provided one or more sets of cooperating members, in which one of the cooperating members drives the other. It is not uncommon for these cooperating members to move in a cooling medium or liquid, which is generally some type of lubricating oil, and frequently the oil is force circulated about and between the engaging surfaces of the cooperating members so as to

continuously lubricate and cool them. In order to accomplish circulation of the cooling medium within blocker rings, clutch plates, transmission bands and the like, the prior art has provided grooves or slots directly in the engaging surfaces of one or both of the cooperating members or in friction material affixed thereto. For example, such a friction material may be a brass coating or a paper liner as seen in U.S. Patent 4,267,912 to Bauer et al., U.S. Patent 4,878,282 to Bauer, and U.S. Patent 4,260,047 to Nels.

Forming grooves within the friction material of cooperating members not only adds complexity to the manufacture of such friction material and the power transmission-absorption device, but also is limited in its ability to circulate cooling medium therethrough. In order to reduce or eliminate the hydrodynamic friction stemming from oil or cooling medium lying on the surface of the friction material engaging the driving member, an improved friction material for circulating the cooling medium is required, especially one which may be varied according to desired parameters.

Prior art friction materials also include certain pyrolytic carbon friction materials as seen in U.S. Patent 4,700,823 to Winckler and U.S. Patent 4,291,794 to Bauer. In such friction material, a meshed cloth substrate formed of carbon fibers is provided with a coating of carbon or other material being deposited on the fibers by chemical vapor deposition. This type of friction material has the characteristic of a relatively open mesh which allows ready penetration by an adhesive for improved bonding, as well as a certain degree of porosity therethrough. However, as pointed out in the '794 patent, grooving of such material is still provided in order to permit the flow of the cooling fluid between the friction faces of the cooperating members of the

power transmission or energy absorption assembly. This type of friction material also does not easily provide highly bonded fibers at a friction surface of the material nor does it achieve a highly controlled texture as needed. Moreover, it has been found that such friction material is difficult to compress to a desired thickness, such as during the process of bonding it to a member.

It is also seen that such pyrolytic friction material utilizes as its substrate a plain weave of the type illustrated in Fig. 6, where both the fill and warp yarns of the material contact the cooperating element. Such an arrangement leads to increased wear of the friction material due to the effect on the yarns oriented perpendicularly to the direction of motion for the cooperating element. Therefore, an additional desired feature not found in prior art devices is a friction surface texture which reduces wear on the friction material.

U.S. Patent No. 4,878,282 illustrates a method for producing friction plates, synchronizing blocker rings and similar structures which use friction lining material applied as a continuous member onto a support where the ends of grooves are opened by removal of the friction lining material which close the grooves. This required several manufacturing steps, including cutting the material, assembling the material to the support, densifying the material once it was on the support and then trimming off a portion of the material. Unfortunately, the use of this type of process created, for example, about 20% scrap material.

Therefore, a further desired feature not found in prior art systems and methods is to provide a material and process which reduces the amount of scrap, yet which provides the advantages of a grooved material, including

facilitating improving the engagement between the frictional support on which the material was mounted and a mating frictional member.

Summary of the Invention

In accordance with one aspect of the present invention, a material is disclosed having a plurality of first yarns and a plurality of second yarns woven with the plurality of first yarns to form a predetermined arrangement in order to control fluid flow.

A second aspect of the present invention is a friction power absorption or power transmission assembly of the type having means for changing the relative position between a friction material and an opposing surface material from a position of complete engagement to a position of complete disengagement, the assembly including a first member, a second opposing member, a friction facing material affixed to one of the first and second members, the friction facing material being a woven fabric having a plurality of first yarns positioned in substantially parallel relationship to each other and a plurality of second yarns woven in serpentine fashion over and under the first yarns to form a texture having a plurality of plateaus and valleys, wherein only the plateaus of the woven fabric engage the other of the members, and means for introducing a liquid cooling medium between the first and second members.

In still another aspect of the invention, this invention comprises a friction lining material for use on a vehicle comprising a material having a first edge and a second edge comprising a rib portion, the lining material comprising a plurality of apertures and each of the plurality of apertures extending between the first edge and the rib portion a predetermined distance and defining

a plurality of slots extending between the first edge and the rib portion, with each of the plurality of slots defining an open end associated with the first edge and a closed end associated with the second edge, the open end defining a first width and the closed end defining a second width, the first width being larger than the second width when the lining material is situated on a friction element.

In yet another aspect of the invention, this invention comprises a method for forming a friction member for use on a vehicle comprising the steps of slotting a friction material to form spaced slots on a friction material having a open end associated with a first edge of the friction material and a closed end associated with a second edge of the material forming the friction material into a frusto-conical shape such that an open end of each of the spaced slots is wider than a closed end of the spaced slots by a predetermined distance and bonding the friction material onto a support ring.

Further, a method of making a friction facing material for use in a power absorption-transmission assembly is disclosed involving the steps of weaving a plurality of yarns in a predetermined pattern so as to form a woven fabric having a texture with a plurality of plateaus and valleys therein, fixing the woven fabric yarns in position, and providing an adhesive to the woven fabric.

Accordingly, one objective of the present invention is to provide a friction facing material for use with cooperating members of a power transmission-absorption device which is able to circulate cooling medium therethrough without the need for machining additional grooves or slots.

A further objective of the present invention is

to provide a friction facing material for use with cooperating members of a power transmission-absorption device which can be oriented with respect to the direction of movement between the cooperating members so as to reduce wear and provide cooling.

Yet another objective of the present invention is to provide a friction facing material for use with cooperating members of a power transmission-absorption device which can be woven so as to include flow channels of desired size and orientation.

Another object of the invention is to provide a material and method which will facilitate reducing the amount of scrap generated during the manufacture process.

Still another object of the invention is to provide a material and method which provides a plurality of slots having open ends which are wider than closed ends when the material is formed into a frusto-conical shape.

Still another object of the invention is to provide a material and method which utilizes a plurality of raised ribs and/or chamfers to facilitate controlling the amount of fluid directed towards or away from the frictional engagement between the material and a mating member.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings, and the appended claims.

Brief Description of the Drawings

While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed that the same will be better understood from the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a front view of a blocker ring having a friction facing material bonded thereon in accordance with the present invention;

Fig. 2 is an enlarged, partial cross-sectional view of the blocker ring in Fig. 1;

Fig. 3 is an exploded perspective view of the blocker ring depicted in Figs. 1 and 2 with its cooperating elements in a typical power transmission-absorption assembly;

Fig. 4A, which is shown on the same sheet as Fig. 2, is an enlarged, diagrammatic side view of the friction facing material of Figs. 1-3 prior to bonding;

Fig. 4B, which is shown on the same sheet as Fig. 2, is a partial, magnified view of a single yarn in the friction facing material of Fig. 4A;

Fig. 4C, which is shown on the same sheet as Fig. 2, is a partial, diagrammatic side view of the channels defined in the friction facing material of Fig. 4A, where the plateaus and low points are depicted in their state after bonding;

Fig. 5 is a photograph of the friction facing material depicted in Fig. 4A;

Fig. 6 is a photograph of a prior art friction facing material having a plain weave;

Fig. 7 is a diagrammatic depiction of several exemplary weave styles which may be employed in the friction facing material of the present invention;

Fig. 8 is a diagrammatic depiction of the friction facing material of the present invention being circumferentially arranged as non-interlocking arcuate segments on a clutch plate;

Fig. 9 is a diagrammatic depiction of the friction facing material of the present invention being circumferentially arranged as interlocking arcuate segments on a clutch plate;

Fig. 10 is a diagrammatic depiction of the friction facing material of the present invention being arranged as a plain cut full ring on a clutch plate;

Fig. 11 is a diagrammatic depiction of the friction facing material of the present invention being arranged as an edge wound full ring on a clutch plate;

Fig. 12A is a diagrammatic depiction of a strip of the friction facing material of the present invention, where a plurality of notches have been formed therein;

Fig. 12B is a diagrammatic depiction of the strip of friction facing material shown in Fig. 12A arranged on a clutch plate;

Fig. 13A is a diagrammatic depiction of a strip of friction facing material of the present invention, where a plurality of lances have been formed therein;

Fig. 13B is a diagrammatic depiction of the strip of friction facing material shown in Fig. 13A arranged on a clutch plate;

Fig. 14 is a diagrammatic depiction of friction facing materials having different weave patterns, including some with several layers of different weave patterns, being circumferentially arranged as non-interlocking arcuate segments on a clutch plate;

Fig. 15 depicts an enlarged, diagrammatic side view of an alternate embodiment for the friction facing material of the present invention;

Fig. 16 is an enlarged diagrammatic side view of a third embodiment of the friction facing material of the present invention;

Fig. 17 is an enlarged diagrammatic side view of a fourth embodiment of the friction facing material of the present invention;

Fig. 18 is a plan view of a synchronizer ring in accordance with another embodiment of the invention;

Fig. 19 is a sectional, fragmentary view of a

portion of the synchronizer ring shown in Fig. 18, illustrating a raised rib;

Fig. 20 is a sectional, fragmentary view of a portion of the synchronizer ring shown in Fig. 18 illustrating a chamfer;

Fig. 21A illustrates the material in a generally rectangular and elongated form showing a plurality of slots which are generally perpendicular to an edge of the material;

Fig. 21B is a view similar to Fig. 21A showing the slots situated on an angle ϕ;

Fig. 21C is a view similar to Fig. 21A showing a slotted, arcuately-shaped material;

Fig. 22A is a view illustrating the material formed into a frusto-conical hoop prior to being situated on the ring, illustrating the widening of the slots at their open end;

Fig. 22B is a view similar to Fig. 22A; and

Fig. 23 is a general schematic diagram of a process for bonding the material onto the ring.

Detailed Description of the Invention

Referring now to the drawing in detail, wherein identical numerals indicate the same elements throughout the figures, Fig. 1 depicts a blocker ring 10 including a friction facing material 15 affixed to an inner annular wall 12 thereof in conjunction with the present invention. It will be understood that blocker ring 10 is one element of a power transmission or absorption assembly such as that utilized in clutches, brakes, automatic transmissions, limited slip differentials, hoists and other similar friction power transmission and energy absorption devices. One example of the environment in which blocker ring 10 may be utilized is

disclosed in U.S. Patent 4,732,247 to Frost, which is hereby incorporated by reference. While blocker ring 10 and friction facing material 15 discussed herein may be utilized with such friction power transmission and energy absorption devices, it will be understood that friction facing material 15 of the present invention is not limited to such specific devices. For example, friction facing material 15 may be utilized in other friction devices such as clutch plates, torque converter clutches, and transmission bands. Moreover, it is contemplated that the material of the present invention could be utilized in other devices where the control of fluid flow is required, such as gaskets, filters, nozzles, and the like.

As seen in Fig. 1, blocker ring 10 includes three raised lugs 14 equally spaced at 120° intervals around blocker ring 10. Lugs 14 may be nested within associated hub notches of another member 17 of the assembly (not shown). As best seen in Fig. 3, blocker ring 10 also has a toothed or splined surface 16 formed on the outer circumference thereof which is engagable with member 17 of the power transmission-absorption assembly and thereby able to clock or rotate member 17 in accordance with a cooperating friction element 18 causing movement along inner annular wall 12. As best seen in Figs. 1 and 2, friction facing material 15 of the present invention is affixed to inner annular wall 12 of blocker ring 10 by means of a layer of adhesive 20, such as nitrile phenolic adhesive. It will be understood that cooperating friction element 18 (see Fig. 3) is movable along a longitudinal axis 19 in order to engage and disengage blocker ring 10.

Fig. 4A depicts a diagrammatic side view of friction facing material 15 in its initial state, which includes a plurality of substantially linear fill yarns

25 arranged substantially parallel to each other. A plurality of substantially parallel warp yarns 30 shown in a sinusoidal side view in Fig. 4A are woven with fill yarns 25 in a serpentine fashion (i.e., over and under adjacent fill yarns 25) to form a series of high points 32 (known as "plateaus") and a series of low points 34 (known as "adhesion points"). Positioned between each warp yarn 30 is a second set of warp yarns 31, which also are woven in serpentine fashion with fill yarns 25 to form a series of plateaus 33 and a series of adhesion points 35. However, in order to maintain the construction of friction facing material 15, warp yarns 31 are out of phase with warp yarns 30 so that plateaus 32 of warp yarns 30 are opposite adhesion points 35 of warp yarns 31 and adhesion points 34 of warp yarns 30 are opposite plateaus 33 of warp yarns 31. By weaving warp yarns 30 and 31 with fill yarns 25 in this way, a plurality of upper channels 36 and 37 (known as "valleys") are formed between adjacent plateaus 32 and adjacent plateaus 33, respectively. Likewise, a plurality of lower channels 38 and 39 may be formed between adjacent adhesion points 34 and adhesion points 35.

Further, as best seen in Fig. 5, fill yarns 25 may be tensioned by a greater amount than warp yarns 30 and 31, which also facilitates defining the formation of upper channels 36 and 37 in a predetermined or desired weave pattern. Because plateaus 32 and 33 of warp yarns 30 and 31 extend above fill yarns 25, it will be understood that only warp yarn surfaces 30a at plateaus 32 and warp yarn surfaces 31a at plateaus 33 (see Fig. 4A) of friction facing material 15 will engage cooperating friction member 18. In order to reduce wear of friction facing material 15, it is preferred that warp yarns 30 and 31 be positioned so that they are aligned

substantially parallel to longitudinal axis 19 (see Figs. 3 and 4A) which is also the direction of relative motion between blocker ring 10 and cooperating friction element 18 to reduce wear on friction facing material 15. It is to be noted that some prior art materials provide warp yarns and fill yarns having engaging surfaces at the same level (see Fig. 6). Consequently, at least some of the yarns are oriented substantially perpendicular to the direction of movement between the cooperating friction members. This, in turn, causes increased wear of the material and/or the cooperating friction member. It should also be noted that while warp yarns 30 and 31 are shown as being woven with substantially linear fill yarns 25, the warp yarns may be substantially linear and two sets of fill yarns may be woven therewith.

It will also be noted that a layer of adhesive 20 is preferably provided so that it engages only adhesive points 34 and 35 of warp yarns 30 and 31, respectively. In this way, both upper channels 36 and 37 and lower channels 38 and 39 (see Fig. 4A) are able to provide flow paths for cooling medium, such as oil, in the power transmission-absorption assembly.

As depicted by the side view representation in Fig. 4C, it will be understood that upper channels 36 and 37, as well as lower channels 38 and 39, preferably have tapered sides 41 and 42. An angle ϕ exists between side walls 41 and 42 and the respective plateaus and adhesion points of warp yarns 30 and 31, with angle ϕ having an angle in the range of 20°-70°, and preferably approximately 45°. By having channels 36-39 formed in this way, exiting of cooling medium therethrough is facilitated due to the Bernoulli theorem.

Further, it will be seen from Fig. 4C that bonding of friction facing material 15 onto a friction element will have a flattening effect on plateaus 32 and

33 of warp yarns 30 and 31, as well as on low points 34 and 35 thereof.

Fill yarns 25 and warp yarns 30 and 31 preferably are carbonized both before and after weaving, with friction facing material 15 preferably being saturated with resin and cured to further fix fill yarns 25 and warp yarns 30 and 31 in the predetermined or desired weave pattern. Even so, friction facing material 15 will generally retain interconnection between upper channels 36 and upper channels 37, while maintaining desired strength characteristics, provided the resin applied thereto is maintained within a range of about 35-50% of friction facing material 15.

With regard to the construction of fill yarns 25 and warp yarns 30 and 31, it has been found that at least nine (9) twists per inch provide suitable definition of the texture for friction facing material 15. In this way, upper channels 36 and 37 and lower channels 38 and 39 thereof become more distinct, thereby increasing the ability of cooling medium to flow therethrough. It will be understood that in order for fill yarns 25 and warp yarns 30 and 31 to have nine twists per inch, an angle θ existing between each fibril 26 and a longitudinal axis 28 (see Fig. 4B), is approximately 27° for a yarn having a diameter of .018 inches. Because there is a direct relationship between angle θ and the twists per inch of the yarn, it will be understood that angle θ increases as the twists per inch of the yarn increases. Thus, an angle θ of 27° or greater for fibrils 26 of each yarn will consequently provide the desired definition of the texture for friction facing material 15, as well as a column strength that will desirably protect against compressive loads.

It will also be understood that during the yarn manufacturing, the fibrils 26 of warp yarns 30 and 31

will fracture at various points due to the stretching thereof while in a carbonized state. Accordingly, such fibrils 26 may have a length of approximately 1/4 to 1 1/2 inch between fracture points 27 (see Fig. 4C). This construction permits heat to be conducted through the length of a yarn by means of fibrils 26 to fracture points 27, whereupon the heat can then be transmitted to the cooling medium contained within lower channels 38 and 39.

Another preference of the embodiment herein described is to weave warp yarns 30 and 31 with fill yarns 25 so that plateaus 32 and 33 of warp yarns 30 and 31 have a maximum surface area across friction facing material 15. One manner of increasing such surface area is to weave warp yarns 30 and 31 over more adjacent fill yarns 25 than the number of adjacent fill yarns 25 they are woven under. For example, warp yarns 30 and 31 may be woven over at least two adjacent fill yarns 25 and under at least one fewer adjacent fill yarns 25 alternatively to create a satin weave fabric (see, e.g., the crowfoot satin weave of Fig. 7, where the dark portions represent plateaus 32 and the white portions represent valleys 36 and 37 therebetween). This type of weave creates rectangular plateaus of increased surface area for contacting a cooperating friction element, which is particularly useful in a dry friction element such as brake and clutch facings, whereby improvement in both wear resistance and thermal conductivity is achieved.

It will be understood, however, that any number of weaves may be utilized or provided with friction facing material 15, including the exemplary weaves shown in Fig. 7 (e.g., plain, crowfoot satin, 2 x 2 basket, 5 HS, 8 HS, Leno, 2/2 twill, 2/1 twill, non-crimp, ± 45° plain, ± 45° 8 HS, and ± 45° crowfoot satin). In fact, such weaves may be selected, designed or utilized to

control the size, number, and orientation of upper channels 36 and 37 and lower channels 38 and 39, and consequently the flow paths across friction facing material 15. Accordingly, the amount and velocity of oil or other cooling medium forced across friction facing material 15 can be controlled.

While a preferred material for friction facing material 15 is carbon, it will be understood that fiberglass, silicone carbide, copper, ceramic, Kevlar, asbestos, or any other material having the required strength, temperature resistance, friction characteristics, and processibility for the intended application may be utilized.

It will also be seen from Figs. 15 and 16 that the friction facing material of the present invention may have several layers of fill and warp yarns. Such a multi-layered arrangement not only improves the durability of friction facing material 15, but may include internal cooling vents which further enhances the flow of cooling oil or air therein. Specifically, as seen in Fig. 15, friction facing material 115 contains fill yarns in a dual layer--single layer--dual layer alternating arrangement. A first set of warp yarns 45 is woven over dual layer fill yarns 47a and 47b and under single layer fill yarns 50 in serpentine fashion so as to form a plurality of high points or plateaus 52 and low points 54. A second set of warp yarns 55, which is positioned between adjacent first warp yarns 45, is woven in serpentine fashion under dual layer fill yarns 47a and 47b and over single layer fill yarns 50 (i.e., substantially 90° out of phase with first warp yarns 45) to form high points or plateaus 56 and low points or adhesion points 58 which are opposite low points 54 and plateaus 52, respectively. A third set of warp yarns 60 is woven between dual layer fill yarns 47a and 47b and

alternatively over and under single layer fill yarns 50, and is preferably positioned between each adjacent first and second warp yarn 45 and 55, respectively. Accordingly, a plurality of upper cooling vents 65 and lower cooling vents 70 are formed within friction facing material 115. Thus, not only are upper channels 46 between adjacent plateaus 52 of first warp yarns 45 and lower channels 48 between adjacent adhesion points 58 of second warp yarns 55 present for flow of oil discharge thereacross, but internal cooling vents 65 and 70 may also be utilized for the flow of cooling oil or air.

Another embodiment of the friction facing material (designated by the number 215) is depicted in Fig. 16, where the multi-layered material thereof may be provided or weaved to include internal cooling vents 75 of predetermined size and shape. As seen therein, multiple layers of substantially linear fill yarns 77 are arranged in a substantially parallel configuration. It will be seen that two sets of warp yarns 78 and 80 are provided for each layer of fill yarns 77, where first warp yarns 78 and second warp yarns 80 are woven in serpentine fashion with fill yarns 77 but in juxtaposition with respect to each other so that plateaus 82 and 84 and valleys 86 and 88 thereof are approximately 90° out of phase. In order to form a relatively large internal cooling or fluid flow vent or channel 75, certain specified fill strands (such as 77A and 77B shown in phantom in Fig. 16) are omitted from various locations and layers to facilitate providing the cooling vent or channel 75 having a predetermined configuration. Accordingly, first warp yarns 78A, 78B and second warp yarns 80A, 80B normally woven with such omitted fill yarns 77A and 77B may be woven with fill yarns 77 of a different layer (e.g., top and bottom fill yarn layers L_1 and L_4 as shown in Fig. 16). While warp yarns 78A, 78B,

80A, and 80B are shown as being woven with top and bottom layers L_1 and L_4 of fill yarns 77, thereby providing the greatest available height dimension h for internal cooling vent 75, it will be understood that fill yarns 77 for any given layer may be omitted to provide internal cooling vents 75 of greater or lesser height h so long as at least two layers of fill strands 77 remain for weaving purposes. Further, any number of adjacent fill yarns 77 may be omitted to give internal cooling vent 75 a greater or lesser width. To simplify weaving, it is preferred that internal cooling vents or channels 75 be of the same size and shape and repeat in symmetric fashion; however, internal cooling vents 75 may be dissimilar and asymmetric according to the needs of a specific application.

Yet another alternative embodiment for the friction facing material of the present invention, identified by the numeral 315, is depicted in Fig. 17, where only a plurality of substantially parallel yarns (indicated as fill yarns 25 but also may be warp yarns) is provided in conjunction with a layer of scrim 21 on blocker ring 10. In this arrangement, it is preferred that scrim 21 be saturated with adhesive or resin (although separate adhesive layers 20a and 20b may be utilized), whereby yarns 25 may be attached thereto and scrim 21 may be attached to inner annular wall 12 of blocker ring 10. It will be understood that a plurality of substantially linear channels 23 will be formed between adjacent fill yarns 25, which may be utilized to conduct lubricating/cooling fluid across friction facing material 315. Depending on a given application, it will be understood that channels 23 can be oriented on a friction element so as to be at an angle between 0° and 90° to the sliding surface of the friction element.

While friction facing material 15 has been

depicted as being positioned on inner annular wall 12 of blocker ring 10, it could just have easily been positioned upon an outer annular wall 22 of cooperating friction element 18 (see Fig. 3). Moreover, as seen in Figs. 8-11, 12B, 13B, and 14, friction facing material 15 may be utilized with other types of friction members such as a clutch plate 90, where it is circumferentially positioned around a front or rear surface 92. There are several ways for friction facing material 15 to be positioned on clutch plate surface 92, such as non-interlocking arcuate segments 94 (see Fig. 8). This arrangement forms channels 95 between each arcuate segment 94 which may permit a greater flow of cooling oil than channels 36 and 37, depending on the width of channels 95. Alternatively, friction facing material 15 may include interlocking arcuate segments 96 to form a complete ring around clutch plate surface 92, as seen in Fig. 9 and disclosed in U.S. Patent 4,260,047 to Nels which is hereby incorporated by reference. As seen therein, each interlocking segment 96 includes a male extension 98 at a first end and a female receptacle 99 at a second end which may be mated together. The advantages of utilizing arcuate segments 94 or 96 for a ring-shaped object like clutch plate surface 92 are that it saves material during the blanking process and allows the yarn cooperating with the mating surface to remain approximately parallel with the direction of engagement and disengagement between the friction elements. Nevertheless, friction facing material 15 may be plain cut (or blanked) as a full ring 100 (see Fig. 10).

Alternatively, a strip of friction facing material 15 may be formed into a flattened hoop 102 so that it may be edge wound about clutch plate surface 92 as seen in Fig. 11. Such a strip of friction facing material 15 preferably includes a single male extension

104 at one end and a single female receptacle 105 at the other end so that each end of hoop 102 may be properly mated.

As seen in Figs. 12A and 13A, strips 106 and 107 of friction facing material 15 may have notches 108 or lances 109 formed therein. Then, strips 106 and 107 may be positioned on clutch plate surface 92 as seen in Figs. 12B and 13B, whereby notches 108 are brought together or lances 109 are pulled apart. In either case, strips 106 and 107 form a multi-sided shape that is sized to fit on clutch plate surface 92.

As shown in Fig. 14, it will be understood that friction facing material of different weaves may be utilized together. There, friction facing material 110, 111, and 112 of various weaves are attached to surface 92 of clutch plate 90 in the form of non-interlocking arcuate segments. It will be seen that friction facing material 110 has the greatest number of flow paths as defined by upper channels 36 and 37 (indicated by white areas 116), thereby permitting the greatest amount of cooling flow. Friction facing material 111 has some flow paths, but fewer than friction facing material 110. Finally, friction facing material 112 has no leakage paths. Thus, depending on the desired amount of cooling medium flow or leakage for a particular area, the friction facing material can be tailored thereto. This may be taken a step further, wherein friction facing material 110, 111, and 112 of different weaves may be radially aligned in several layers as shown in Fig. 14. In this way, complete control of the flow characteristics for a given application may be controlled solely by the weave and arrangement of the friction facing material.

With respect to the method of making friction facing material 15, it will be understood that fill yarns 25 and warp yarns 30 and 31 preferably are initially

carbonized in a high temperature oven. Thereafter, fill yarns 25 and warp yarns 30 and 31 are woven in a designated pattern for the particular application so that channels 36, 37, 38 and 39, and possibly cooling vents 65, 70 or 75, are formed to provide the requisite flow paths. In order to fix or lock the woven pattern of fill yarns 25 and warp yarns 30 and 31, friction facing material 15 is then preferably carbonized again in a high temperature oven. To further enhance the locking process, friction facing material 15 preferably is saturated with a resin, such as a phenolic resin, and cured at an appropriate amount initially in an oven and subsequently at an appropriate amount during the bonding process described hereinafter.

Once the above steps have been accomplished, adhesive 20 is then applied to one surface of the saturated fabric, such as by lamination. Friction facing material 15 is then ready for blanking, where either arcuate segments, whole rings, or strips are cut from the rolls of material. Lastly, friction facing material 15 is bonded to a desired friction element, such as blocker ring 10 or clutch plate 90. It has been found that a punch-die arrangement works well to press friction facing material 15 into place on blocker ring 10. For example, the punch may provide pressure in the range of 50-800 lbs. per square inch for approximately 40-100 seconds. In order to prevent adhesive 20 and phenolic resin from wicking into friction facing material 15 during this process, since adhesive 20 will tend to be attracted to the element having a higher temperature, a temperature differential preferably is established between the punch and the die (e.g., the die preferably having a temperature of approximately 550° F and the punch having an initial temperature of approximately 250° F increasing to approximately 400° F during the bond cycle as heat

moves from the die through the ring adhesive layer, and friction facing material into the punch).

Referring now to Figs. 18-23, another embodiment of the invention is shown. Like parts are identified with the same part number, except and apostrophe ("'") has been added thereto. In this embodiment, a facing material 300' is adhered to blocker ring 16a' with adhesive 20' in the manner described below. In this embodiment, the material 300' may be the woven material described earlier herein or it may be a composition or paper material, such as the material described in U.S. Patent 4,639,392 which is incorporated herein by reference and made a part hereof. In the embodiment being described, the facing material 300' is slotted so that it comprises a plurality of spaced slots 302' (Fig. 21A). Notice that each spaced slot 302' comprises an open end 302a' associated with a first end 304' of material 300' and a closed end 302b' associated with a second end 306' of material 300'. Notice in the embodiment shown in Fig. 21A, that the slots 302' are generally perpendicular to an edge 306a' of second end 306'.

Notice in Fig. 21A that the material 300' is slotted in generally rectangular strips 309' or a plurality of strips (not shown). Alternatively, as shown in Fig. 21C, the slotted material may be provided in an arcuate form for assembly as shown, for example in Figs. 8, 9, 11, 12 and 13B which facilitates improving manufacture and assembly time, as well as reduces scrap generated during the manufacturing process.

Note in Fig. 21C that the slots or lances 302' may define a plurality of openings or open areas as shown. These slots 302' may result from forming the material 300' into an arcuate form or from slotting the material 300' and removing portions of the material to

define the slots or grooves 302'.

Fig. 21B shows another embodiment of the material 300' wherein the material 300' comprises a plurality of slots 310' defining an open end 310a' and closed end 310b', with the opened and closed ends 310a' and 310b' being associated with a first edge 312' and a second edge 314', respectively.

Notice in the embodiment shown in Fig. 21B that the slots are formed on an angle ϕ which in the embodiment being described is on the order of about 45°. However, it should be appreciated that ϕ could be any suitable angle between, for example, 10° and 170° as desired in order to direct fluid flow in the manner described herein.

Once the angle ϕ is selected and the material 300' is slotted in the manner described below, the material is formed into a slotted cylindrical hoop shape of the type shown in Figs. 22A and 22B.

As best illustrated in the enlarged, sectional fragmentary view in Fig. 19, notice that a width, W, associated with the open end 302a' defines a predetermined distance which in the embodiment being described is on the order of about 1-5% larger than a width W1' associated with a narrowest part on the closed end 302b'. Likewise, the widths W of the open ends 302a' relative to the closed end 302b' of the slotted material 300' illustrated in Fig. 22B will be different when the material is formed into the cylindrical hoop as illustrated in Fig. 22B.

As illustrated in Figs. 18-20, 21A and 21B, once the material 300' is formed into the cylindrical hoop, the material 300' may be situated onto the blocker ring 10' and adhered to wall 12' using the adhesive 20' of the type described earlier herein. Notice in the embodiment being described, that when the material 300'

is bonded onto wall 12' of ring 10', a molding member or punch (not shown) may be used to force and compress the material 300' against wall 12' in order to adhere the material thereto and also to form a plurality of raised ribs 320' and/or a plurality of chamfers 322'.

Fig. 19 illustrates an enlarged fragmentary sectional view of a portion of the ring 10' shown in Fig. 18 illustrating the raised ribs 320' which may be formed when the material 300' is forcibly secured and molded onto blocker ring 10'. Likewise, Fig. 20 illustrates an enlarged fragmentary sectional view of a portion of the blocker ring 10' illustrating the chamfer 322' associated with the second edge 306'.

As illustrated in Fig. 18, the material 300' may be formed or molded such that it has alternating chamfers 322' and raised ribs 320', but it should be appreciated that the material 300' may be formed such that it comprises one continuous, circular raised rib (not shown) or one continuous chamfer (not shown) or neither a raised rib 320' nor chamfer 322'. Moreover, the raised ribs and chamfers may be formed in a non-repetitive pattern if desired.

As best illustrated in Figs. 19-20, notice that the ribs 320' and chamfers 322' are positioned at the small end 300a' of the generally tapered inside diameter of the blocker ring 10'. The continuous frictional surface 320a' (Fig. 19) created by the unlanced rib 320' of the material 300' acts as a seal during the engagement process when the material 300' engages a mating frictional member (not shown). This facilitates inhibiting or stopping completely the supply of lubricating oil (not shown) to the engaging frictional interface between the material 300' and the mating frictional member. Stopping this supply of lubricating oil during engagement further reduces the engagement time

by reducing the amount of lubricant that needs to be exhausted to quickly complete the engagement process.

If it is desired to facilitate fluid flow from area 10a' to area 10b' (Fig. 20), then the groove or chamfer 322' may be molded or cut into the material 300'.

Advantageously, this invention provides a convenient system and method for creating grooves when using a composite friction material 300' which is bonded or adhered to blocker ring 10'. It is envisioned that this design and method may be utilized with the woven material of the type described earlier herein or with a traditional paper material used in the past. A significant of the feature of the invention is that its design facilitates and improves material utilization compared to traditional facing configurations and provides low cost for creating grooves in the material 300'.

It should be appreciated that the length L (Fig. 19) of any groove is on the order of about 60-90% of the axial length or blocker ring length, BRL (Fig. 19). This, in turn, leaves the ungrooved portion 300a' to define a length L1 which is on the order of about 10-40% of the blocker ring length BRL, with the total blocker ring BRL equaling the sum of the lengths L and L1.

Advantageously, the grooves 302' define an interrupted operating surface which tends to inhibit the formation of an undesirable hydro-dynamic oil film (not shown) which, in turn, facilitates providing a quick and smooth frictional engagement between the blocker 10' and a mating frictional member (not shown). Thus, when the features of this invention are used with a synchronizer ring 10 of the type shown and described, the invention has been found to facilitate providing a quick and low effort shift between gears of a transmission.

As alluded to earlier herein, the raised rib 320' facilitates "cutting through" the hydro-dynamic oil film during the engagement process. This acts as a seal to reduce or entirely eliminate the supply of oil at the frictional interface to aid in the elimination of oil supply (moving centrifugally from the area 10a' to the area 10b'), thereby quickening the elimination of oil film in the area 10c'.

It has been found that the raised rib 320' may be very economically produced by contouring the molding member or punch (not shown) which is used to force, densify and bond the material 300' onto ring 10'. In this regard, the punch forces the material to densify during the bonding process from a nominal thickness of about .036 inch before bonding to .030 inch after bonding, with the raised rib 320' defining a thickness of about .001 inch so that the overall thickness of the material 300' with a raised rib is on the order of about .031 inch. A method for bonding material 300' onto ring 10' will now be described relative to the schematic shown in Fig. 23.

The process begins at block 340' wherein the adhesive 20' is applied to material 300'. At block 342' the material 300', which is in the generally rectangular and elongated form (Figs. 21A and 21B) is slotted to define the grooves 302'.

At block 344' (Fig. 23) the material 300' is formed into the cylindrical hoop, as illustrated in Figs. 22A and 22B.

At block 346', the bonded punch (not shown) is used to force the material 300' against wall 12' of ring 10'. As mentioned earlier herein, the bonded punch (not shown) may cause the rib 320', chamfer 322' or a series of alternating ribs 320' and chamfers 322' to be provided at the area 10a' (Figs. 19 and 20) to facilitate

achieving some of the advantages mentioned earlier herein.

At block 348' (Fig. 23), the ring 10' is finished and may be assembled, for example, in a transmission (not shown) of a vehicle (not shown).

Having shown and described the preferred embodiments of the present invention, wherein an inventive friction facing material, the method of making the friction facing material, and a friction element including the friction facing material thereon have been disclosed, it will be understood that further adaptations thereof may be accomplished by appropriate modifications by one of ordinary skill in the art without departing from the scope of the invention. In particular, while the embodiments of the inventive friction facing material have been described herein as preferably including warp yarns weaving with a plurality of substantially linear fill yarns, the opposite thereof is also contemplated (i.e., where fill yarns may be woven with a plurality of substantially linear warp yarns). Further, the specific weaves and materials disclosed herein are also preferred embodiments, since the yarns may also be braided, but should not be deemed limiting on the intent of the present invention.

It should also be appreciated that the invention could be applied to a wet or dry environment where the control of fluid flow is required, and the channels defined by the predetermined yarn arrangement may be used to channel heating or cooling fluids, including gases and liquids.

What is claimed is:

CLAIMS

1. A friction lining material for use on a vehicle comprising:

a material having a first edge and a second edge comprising a rib portion, said lining material comprising a plurality of apertures; and

each of said plurality of apertures extending between said first edge and said rib portion a predetermined distance and defining a plurality of slots extending between said first edge and said rib portion, with each of said plurality of slots defining an open end associated with said first edge and a closed end associated with said second edge, said open end defining a first width and said closed end defining a second width, said first width being larger than said second width when said lining material is situated on a friction element.

2. The friction lining material as recited in claim 1 wherein said rib comprises a chamfer.

3. The friction lining material as recited in claim 1 wherein said predetermined distance comprises a distance of between 60-90% of an entire distance between said first and second edges.

4. The friction lining material as recited in claim 1 wherein said first width being at least 2% larger than said second width.

5. The friction lining material as recited in claim 2 wherein said chamfer communicates with said plurality of slots.

6. The friction lining material as recited in claim 1 wherein said lining material comprises a paper material.

7. The friction lining material as recited in claim 1 wherein said lining material comprises a woven material.

8. A friction member comprising:
a metal support ring;
a friction lining material;
an adhesive for securing said friction lining material onto said metal support ring;
said friction lining material defining a frusto-conical shape having a first edge and a second edge, said lining material comprising a plurality of apertures; and
each of said plurality of apertures comprising a predetermined length and defining a plurality of slots extending between said first edge and said rib portion, with each of said plurality of slots defining an open end associated with said first edge and a closed end associated with said second edge, said open end defining a first width and said closed end defining a second width, said first width being larger than said second width when said lining material is adhered to said a ring member.

9. The friction member as recited in claim 8 wherein said second edge comprises a rib.

10. The friction member as recited in claim 8 wherein said predetermined length comprises a distance of between 60-90% of an entire length between said first and second edges.

11. The friction member as recited in claim 8 wherein said first width being at least 2% larger than said second width.

12. The friction member as recited in claim 8 wherein said second edge comprises a chamfer.

13. The friction member as recited in claim 8 wherein said lining material defines a frusto-conical and partially interrupted bearing surface for engaging a mating member.

14. The friction member as recited in claim 13 wherein said plurality of slots each comprise an imaginary centerline which intersect an axis of said metal support ring.

15. The friction member as recited in claim 13 wherein said second edge comprises a plurality of alternating chamfers and raised ribs.

16. The friction member as recited in claim 8 wherein said friction lining material comprises either a composite or a paper material.

17. The friction member as recited in claim 13 wherein said friction lining material comprises a woven material.

18. A method for forming a friction member for use on a vehicle comprising the steps of:

slotting a friction material to form spaced slots on a friction material having a open end associated with a first edge of said friction material and a closed end associated with a second edge of said material;

forming said friction material into a frusto-conical shape such that an open end of each of said spaced slots is wider than a closed end of said spaced slots by a predetermined distance; and

bonding said friction material onto a support ring.

19. The method as recited in claim 18 wherein said method further comprises the step of forming a raised rib associated with said second edge.

20. The method as recited in claim 18 wherein said method further comprises the step of forming a raised rib associated with said second edge.

21. The method as recited in claim 18 wherein said predetermined distance comprises a distance of between 60-90% of an entire distance between said first and second edges.

22. The method as recited in claim 18 wherein said open end comprises a first slot width and said closed end comprises a second slot width, said first width being at least 2% larger than said second width.

23. The method as recited in claim 18 wherein said method further comprises the step of forming a raised rib associated with said second edge, said raised rib comprising a chamfer which communicates with said plurality of slots.

24. The method as recited in claim 18 wherein said method further comprises the step of forming a chamfer associated with said second edge.

25. The method as recited in claim 18 wherein said method further comprises the step of forming an intermixed pattern of ribs and/or chamfers and/or neither associated with said second edge.

26. The method as recited in claim 18 wherein said method further comprises the step of providing a woven material as said friction material.

27. The method as recited in claim 18 wherein said method further comprises the step of providing a paper composition material as said friction material.

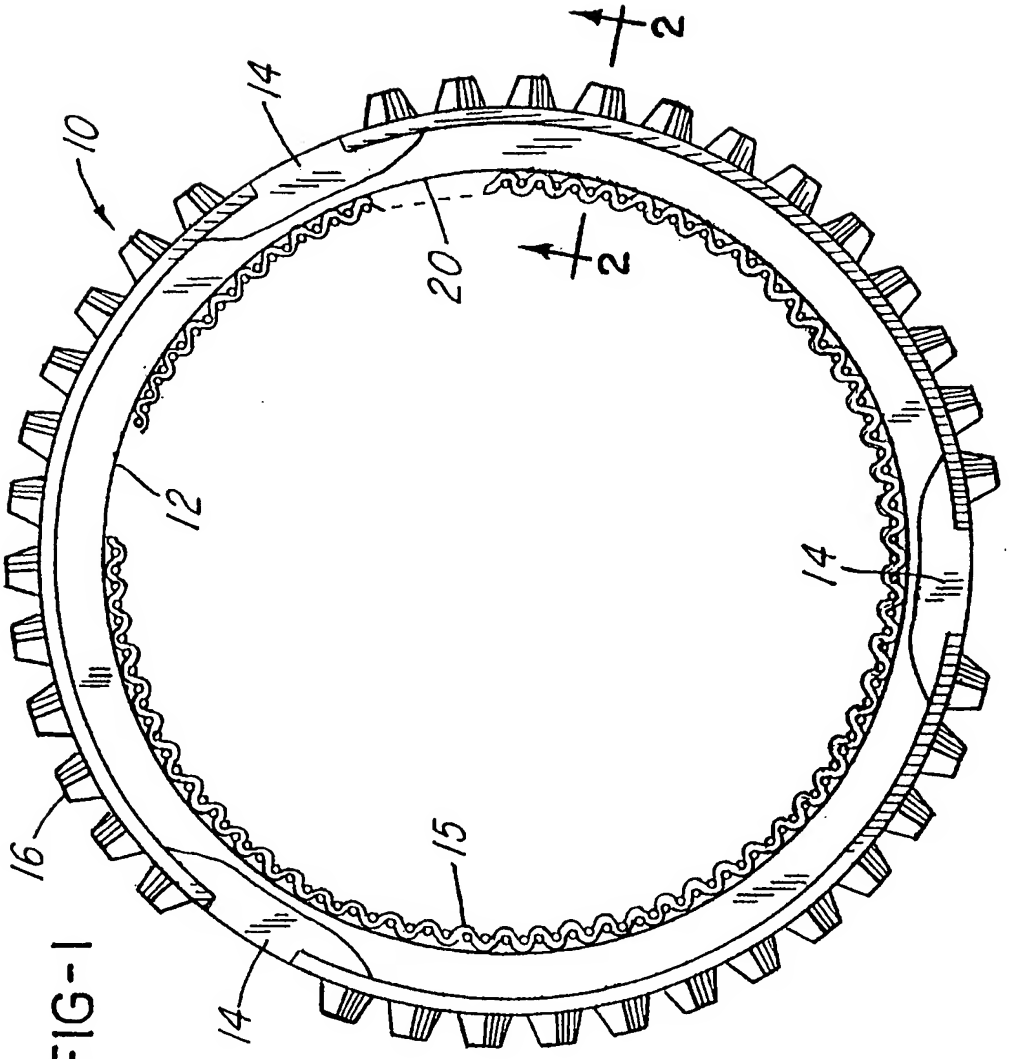


FIG-1

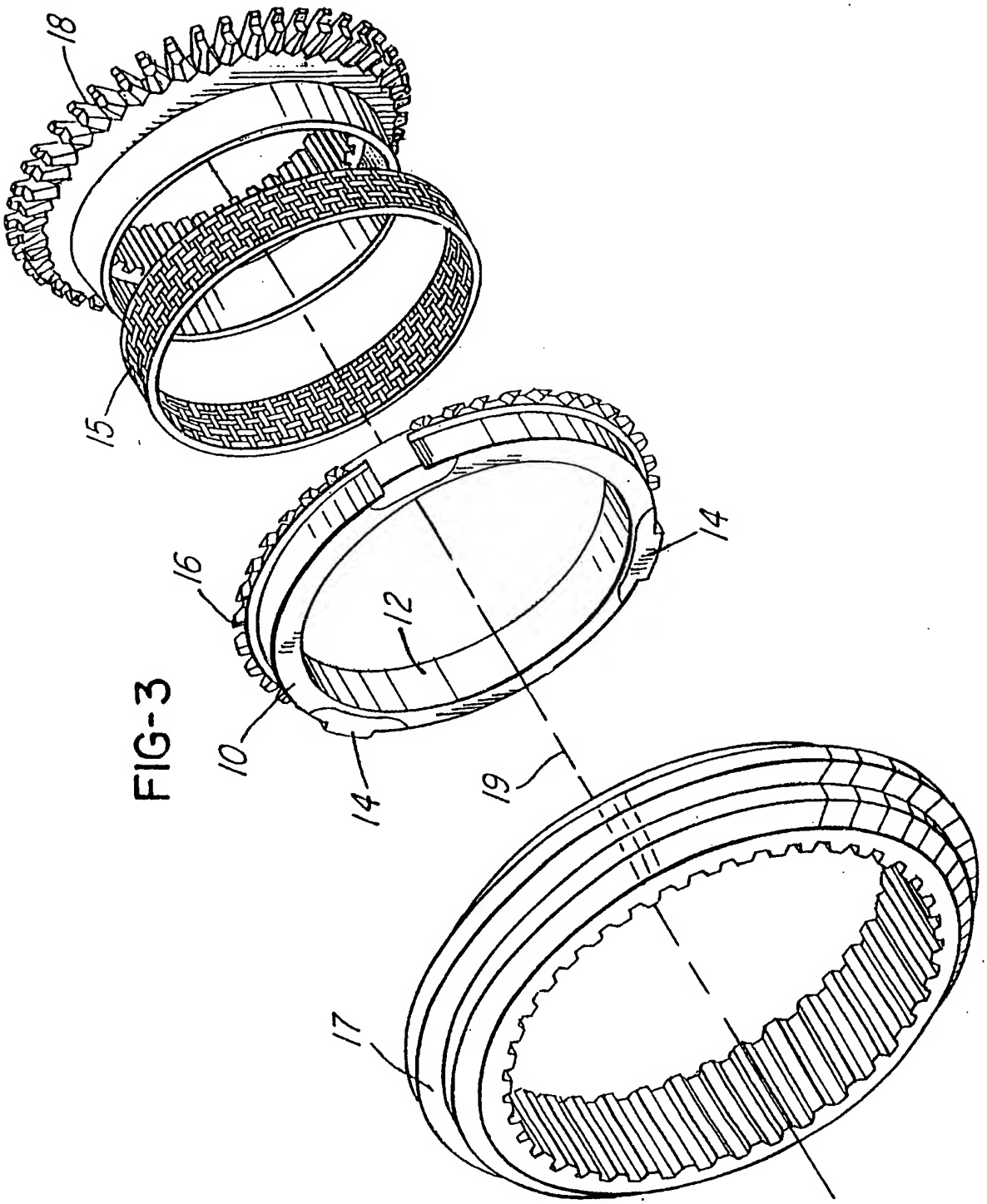


FIG-3

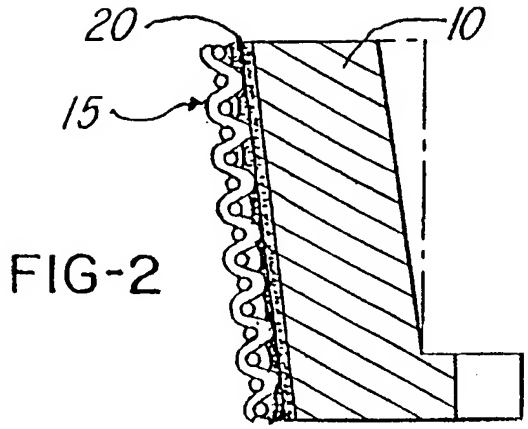


FIG-2

FIG-4A

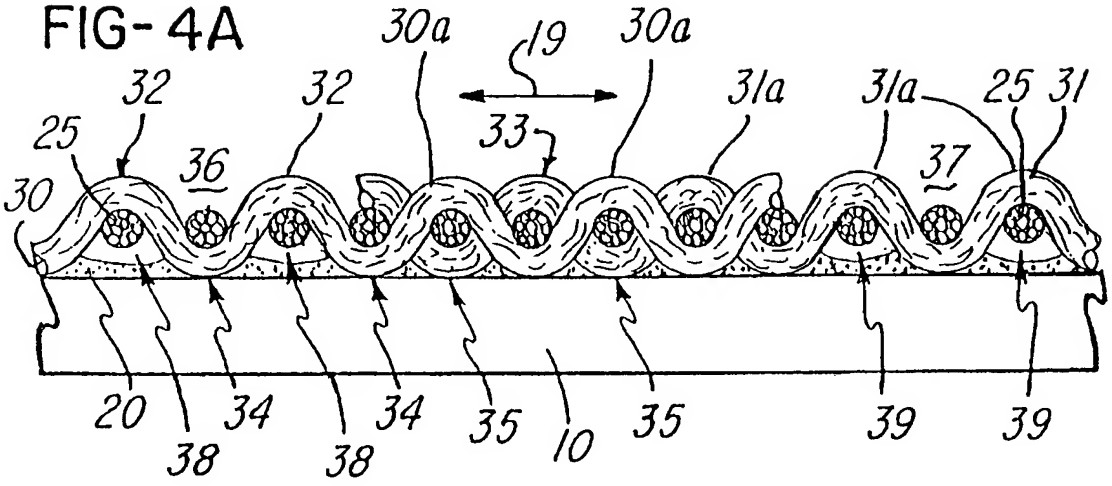


FIG-4B

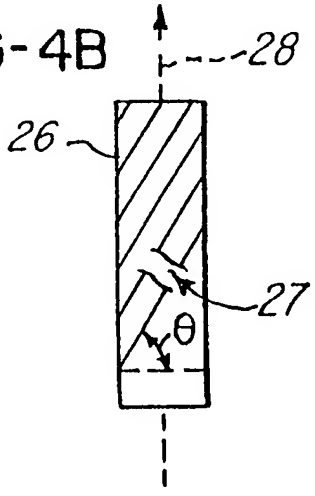
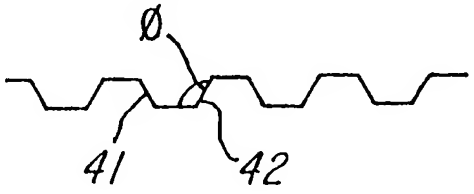


FIG-4C



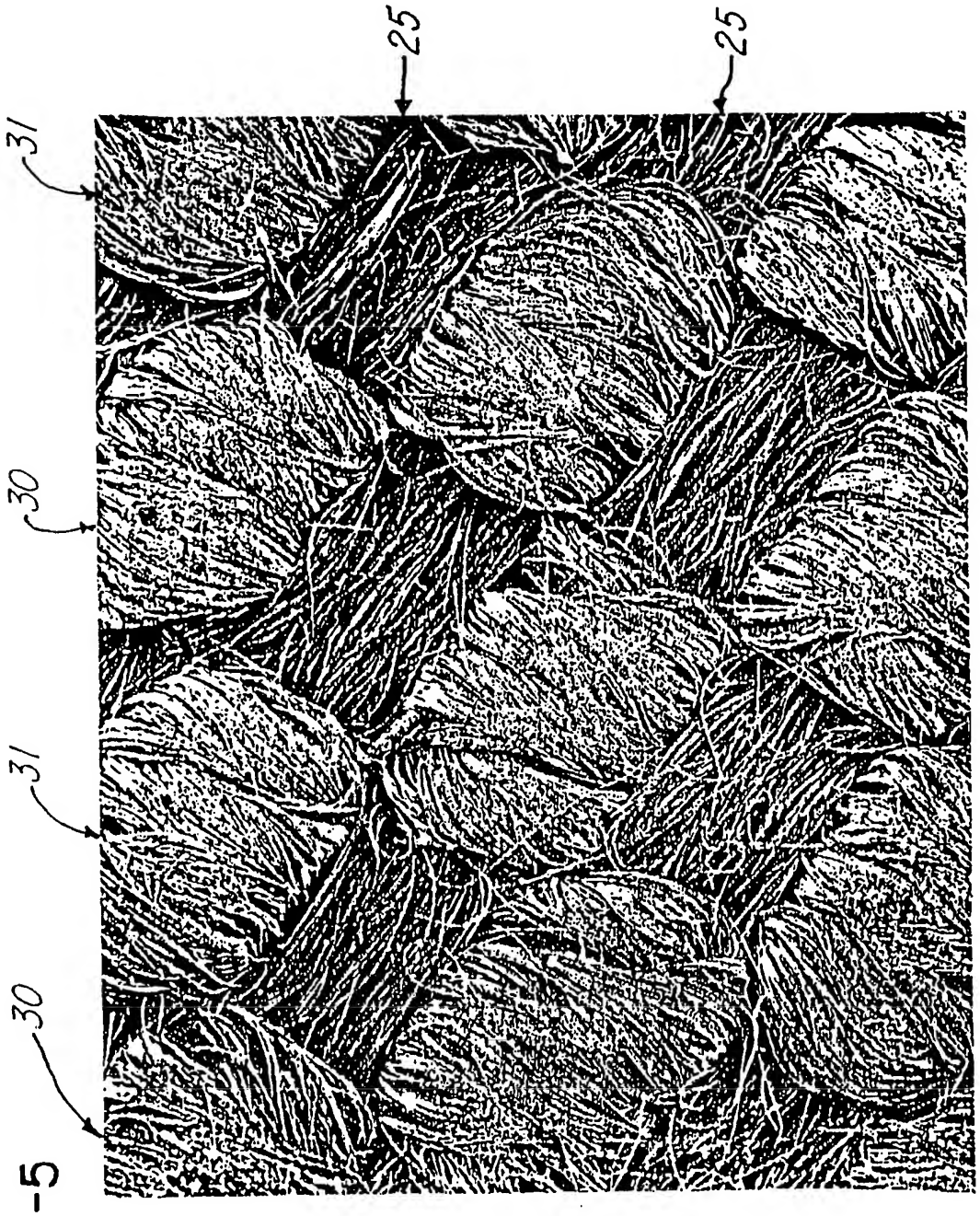


FIG-5

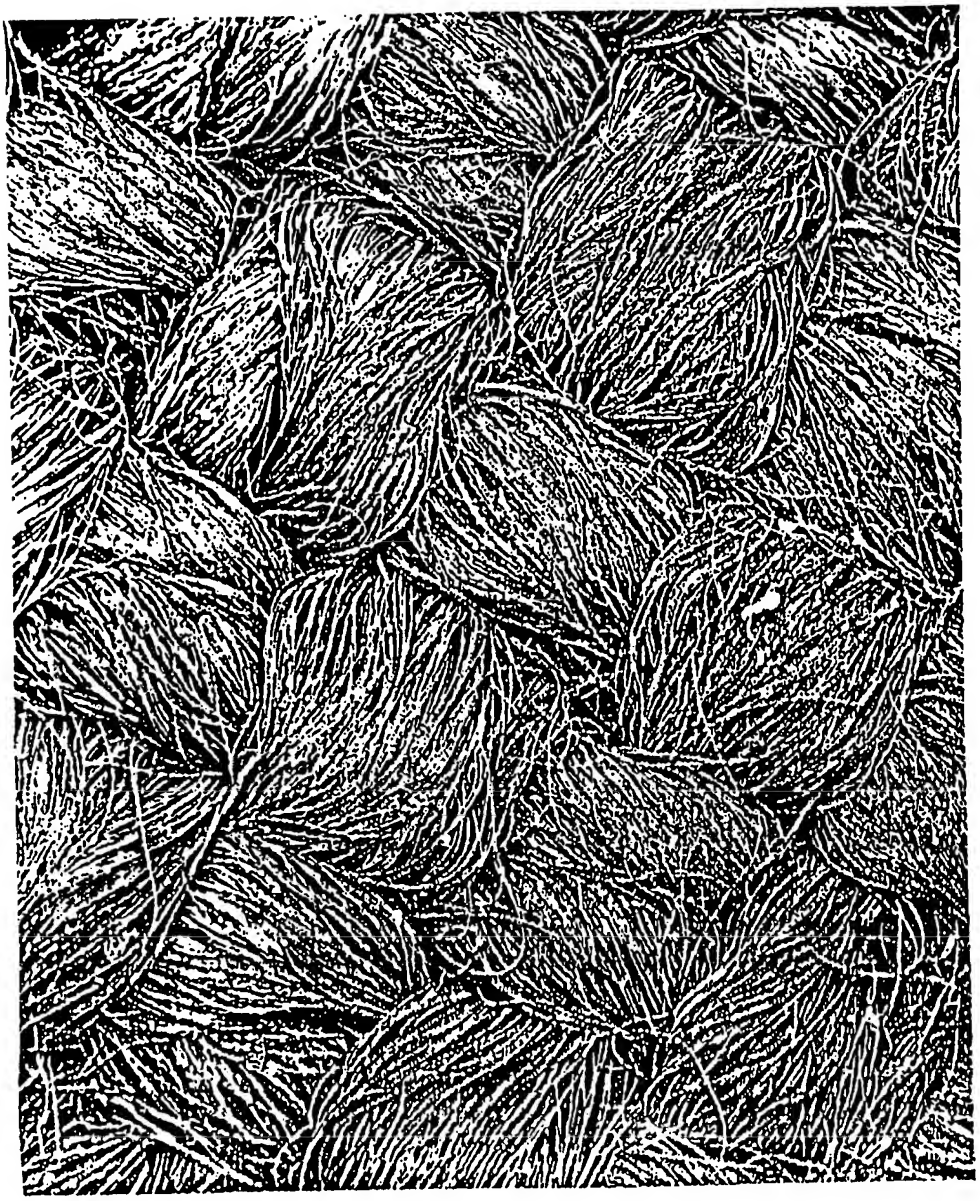


FIG-6
(PRIOR ART)

FIG-7

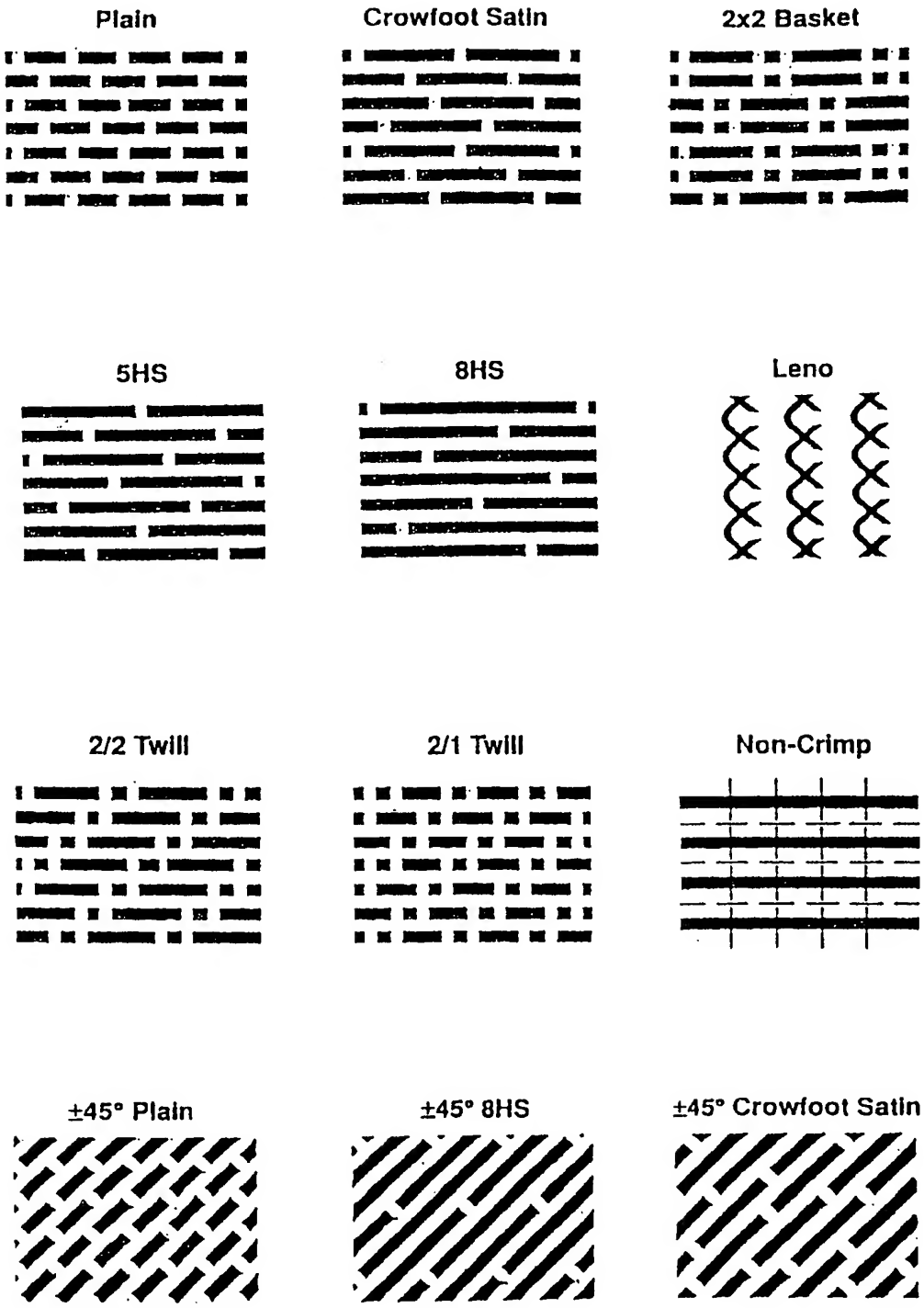

Plain
Crowfoot Satin
2x2 Basket
5HS
8HS
Leno
2/2 Twill
2/1 Twill
Non-Crimp
±45° Plain
±45° 8HS
±45° Crowfoot Satin

FIG-8

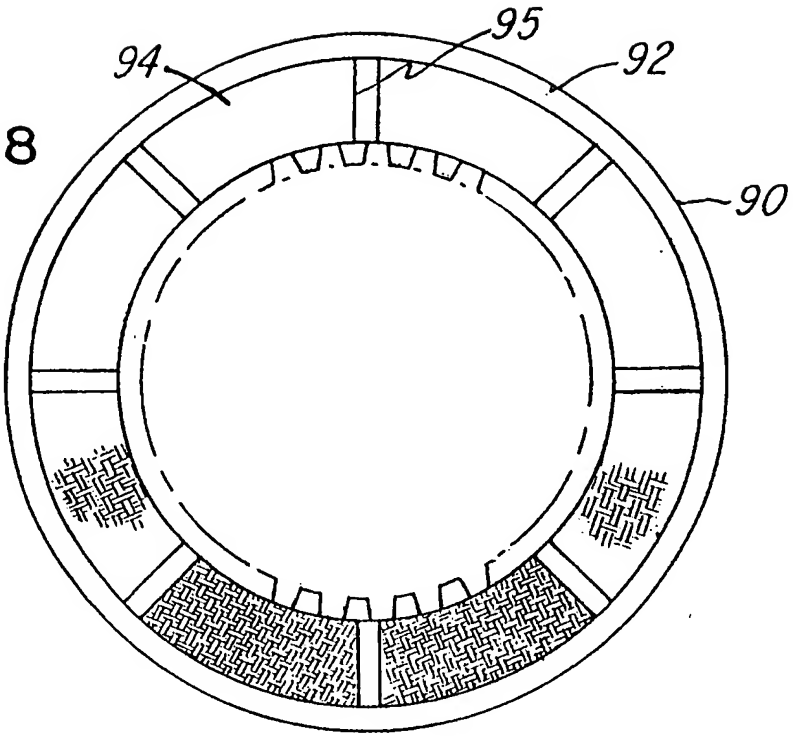


FIG-9

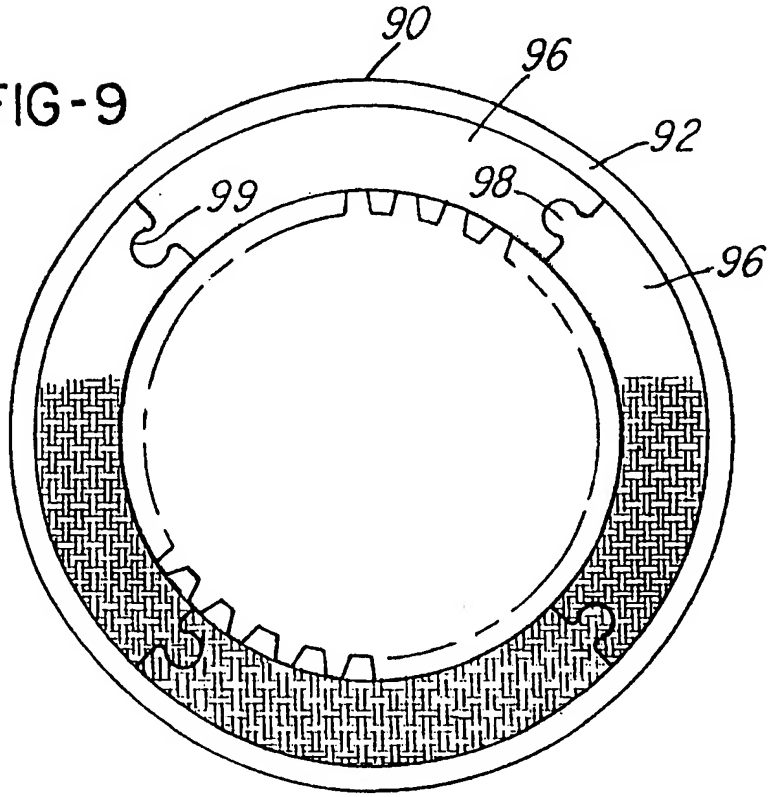


FIG-10

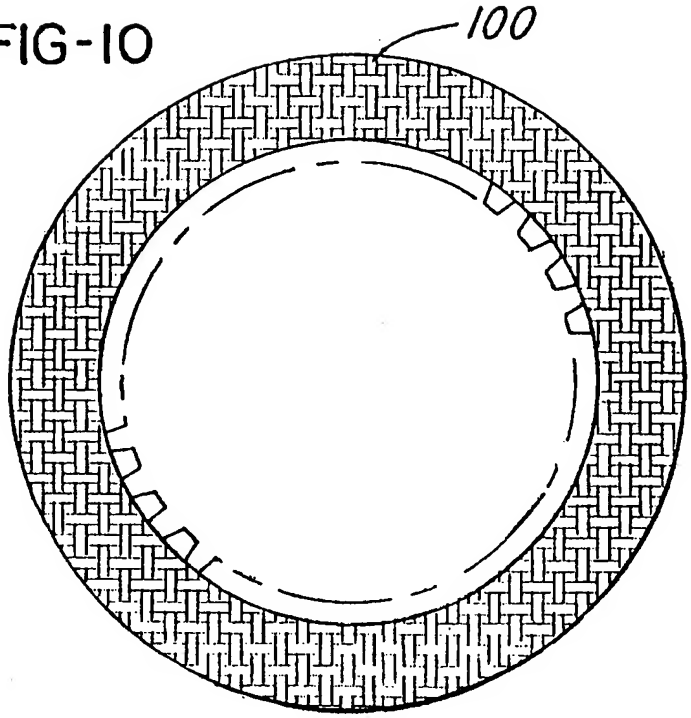


FIG-11

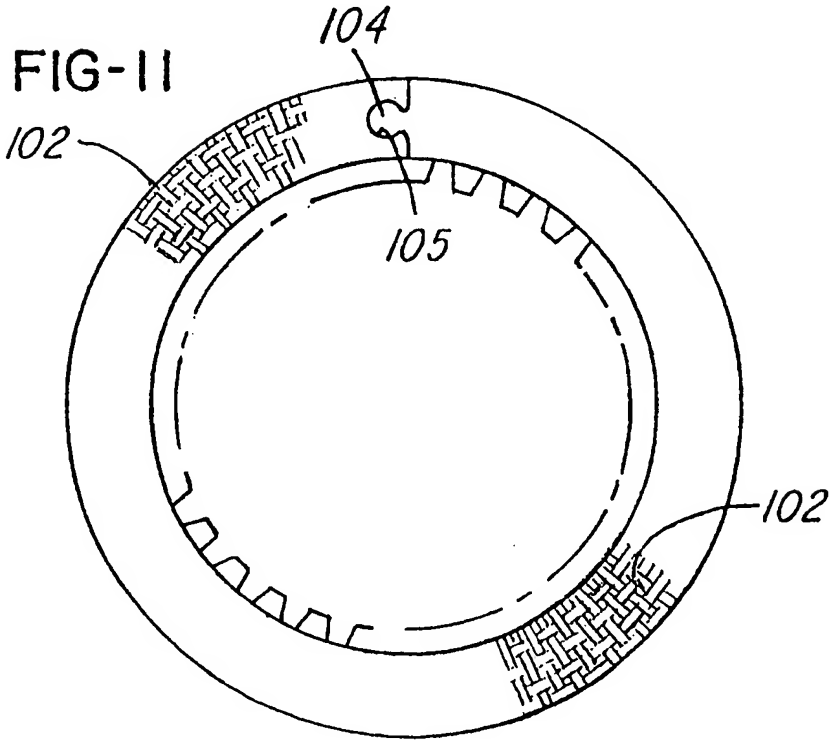


FIG-12A

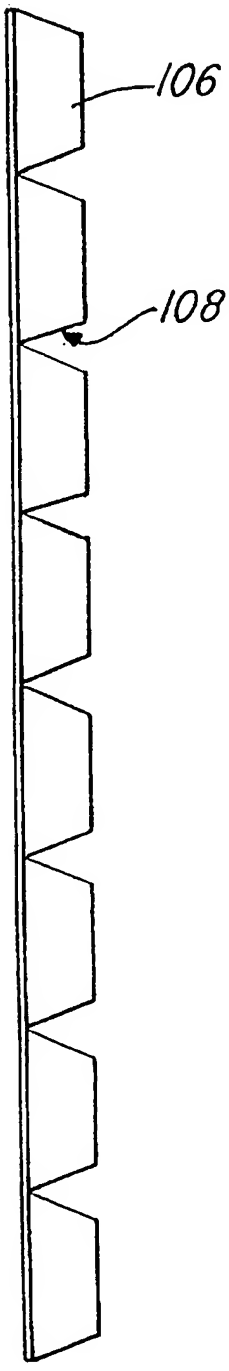


FIG-12B

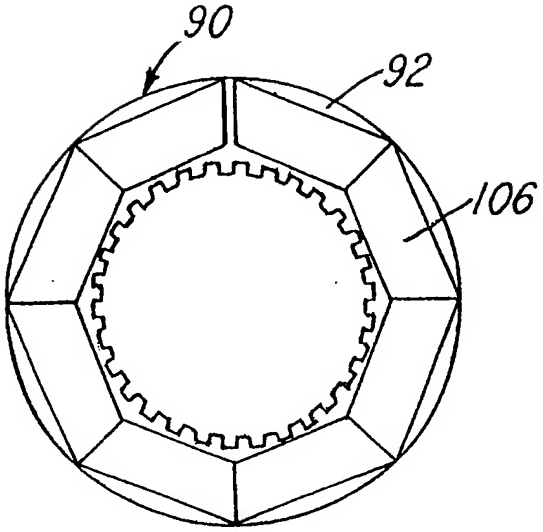


FIG-13A

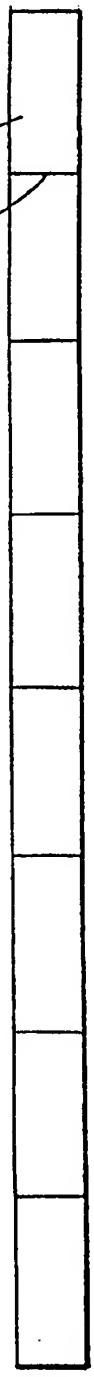
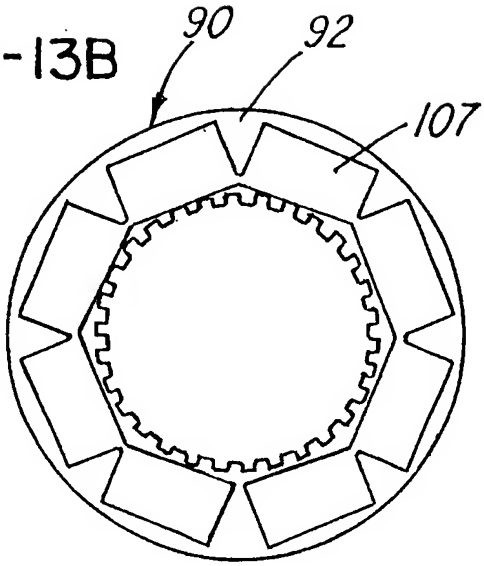


FIG-13B



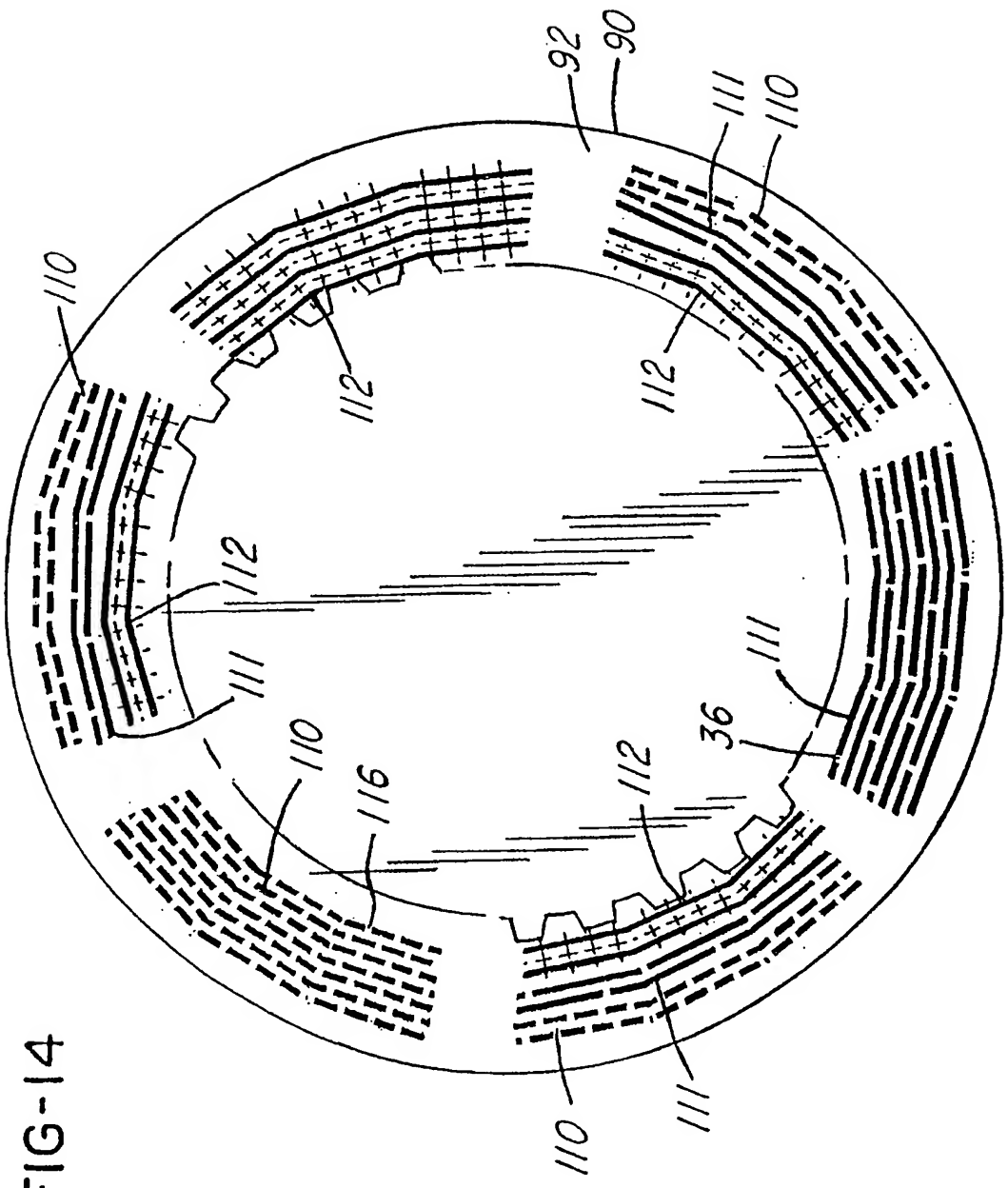


FIG-14

FIG-15

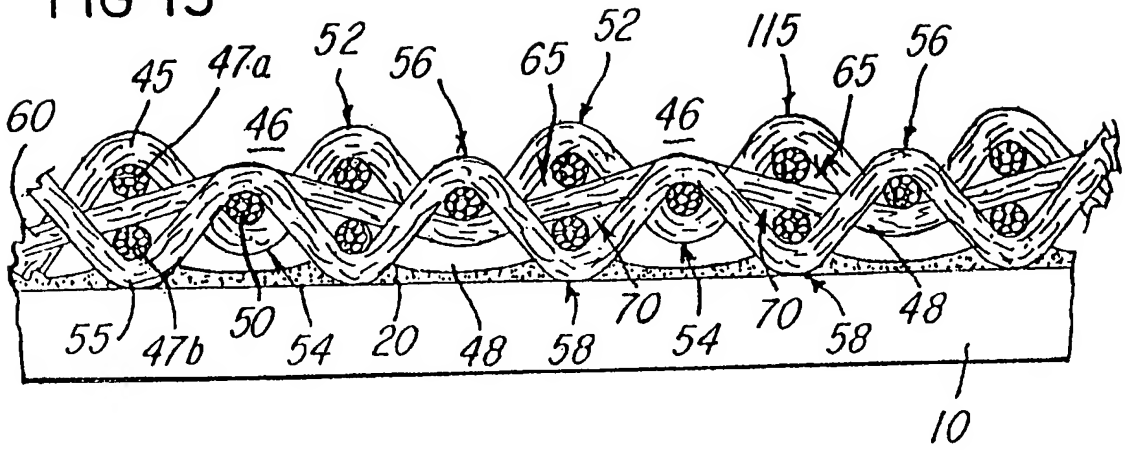
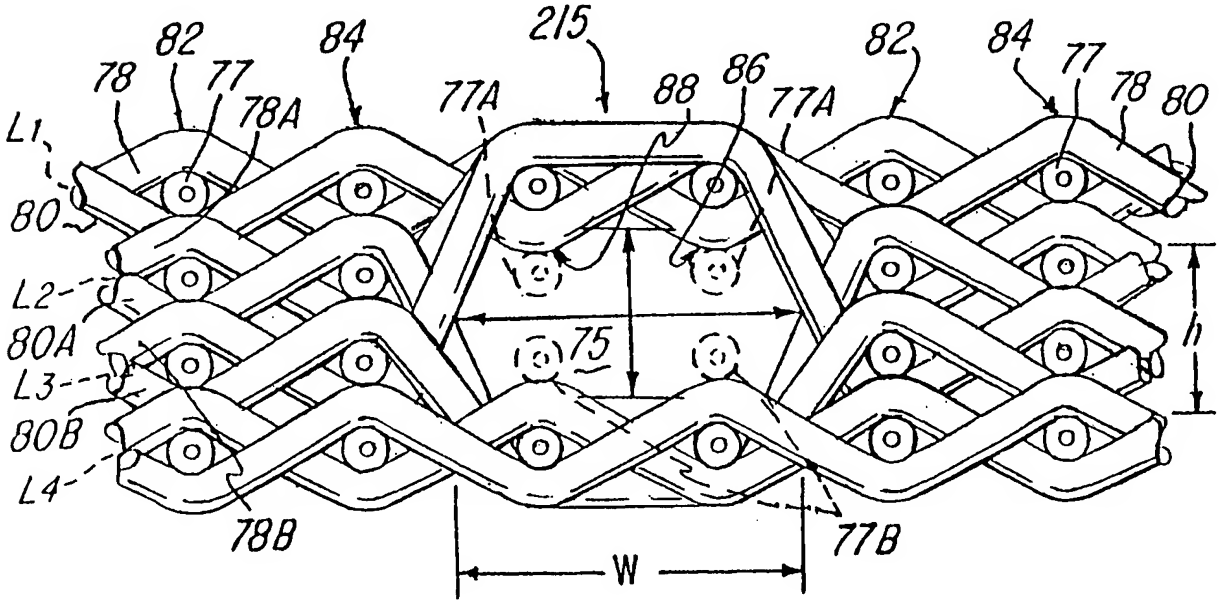

60
45
47a
46
52
56
65
52
46
115
65
56
55
47b
50
54
20
48
58
70
54
70
58
48
10

FIG-16


L1
80
L2
80A
L3
80B
L4
78
82
77
78A
84
77A
215
88
86
77A
82
84
77
78
80
75
h
78B
77B
W

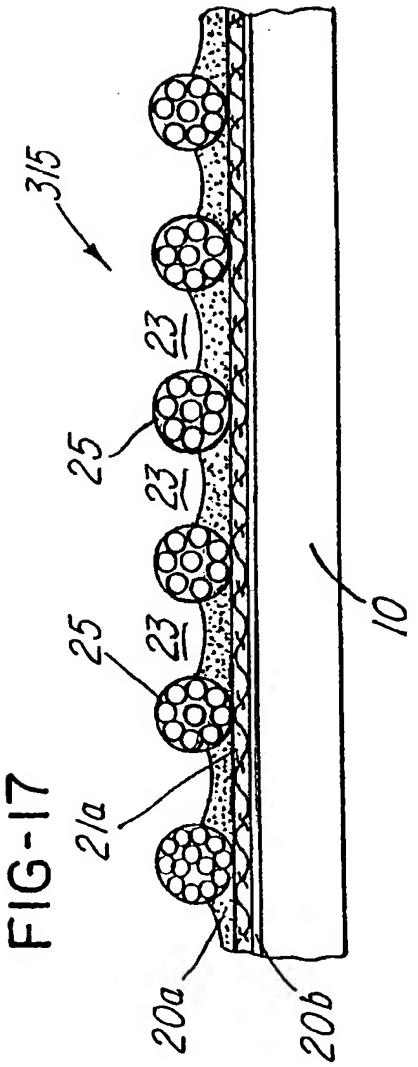


FIG-17

FIG-18

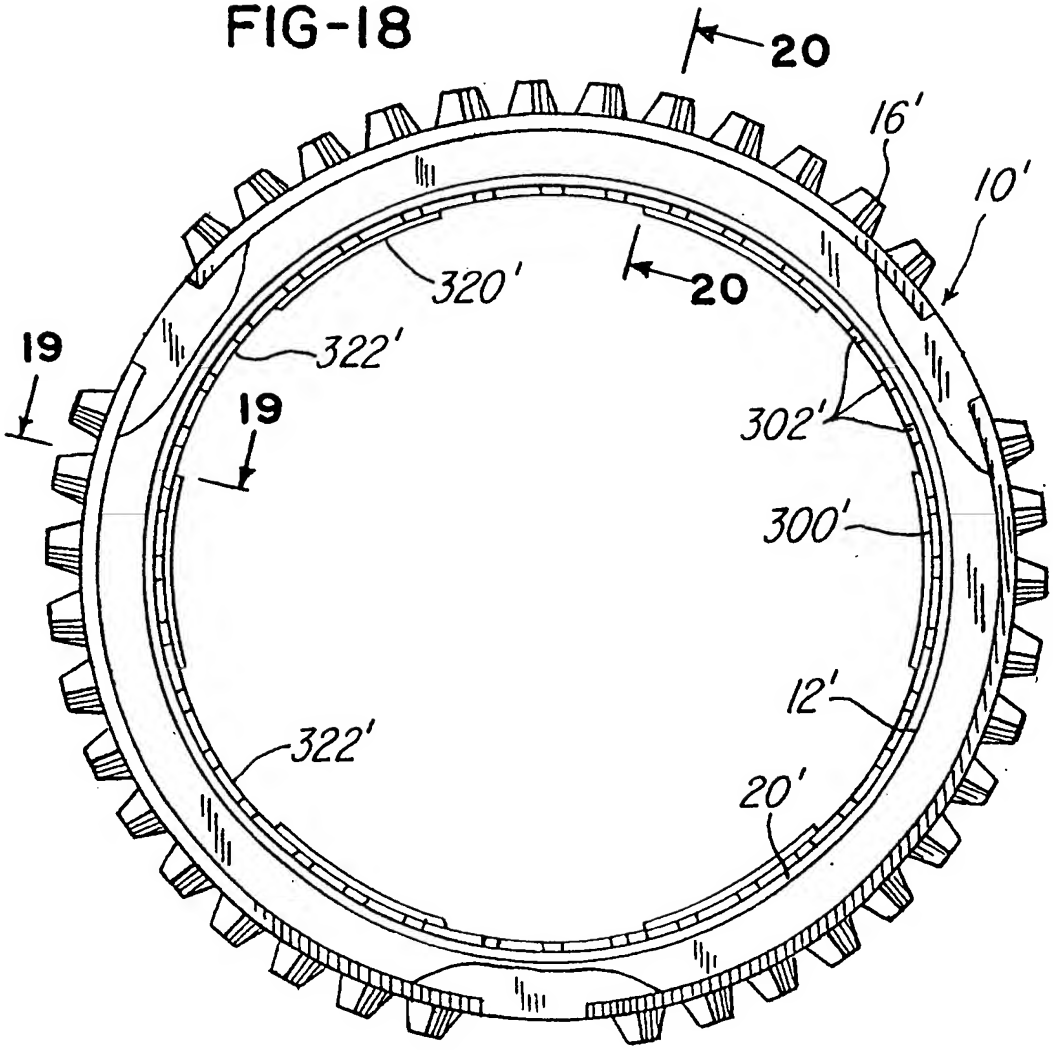


FIG-19

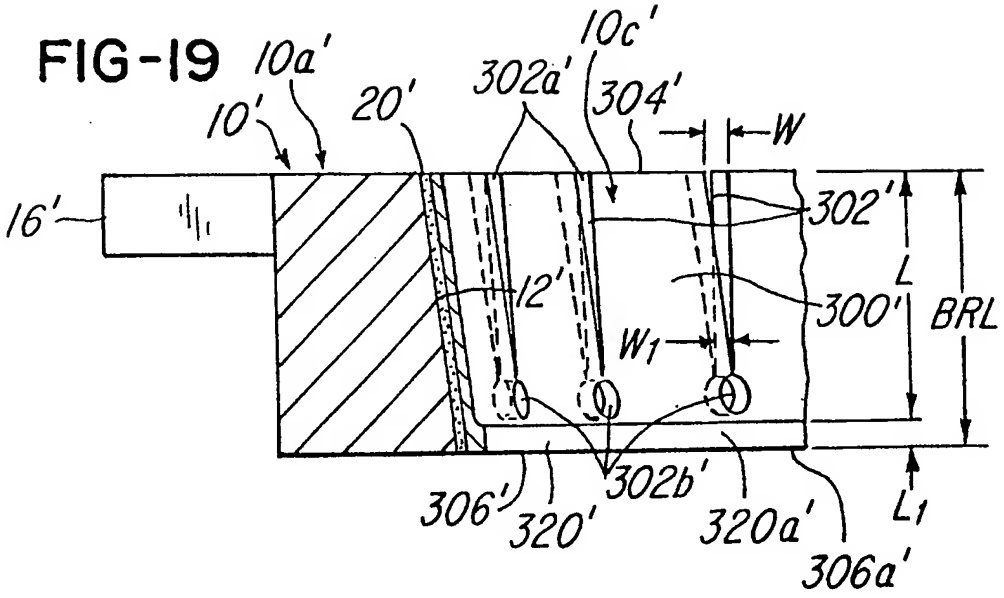
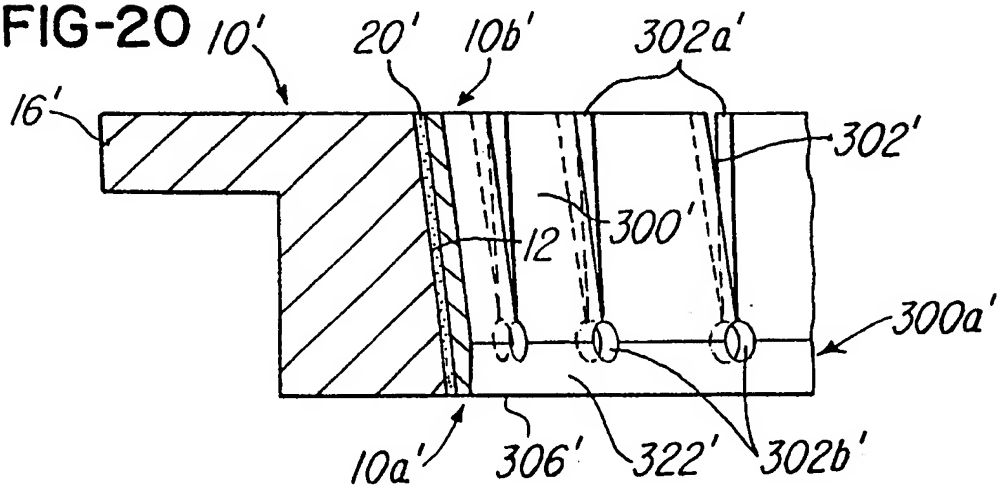

10a'
10'
20'
302a'
10c'
304'
W
16'
302'
12'
L
300'
BRL
W1
306'
320'
302b'
320a'
L1
306a'

FIG-20


10'
20'
10b'
302a'
16'
302'
12
300'
300a'
10a'
306'
322'
302b'

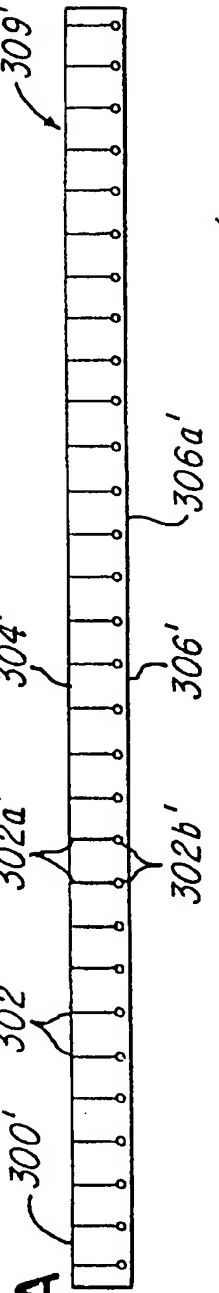


FIG-21A

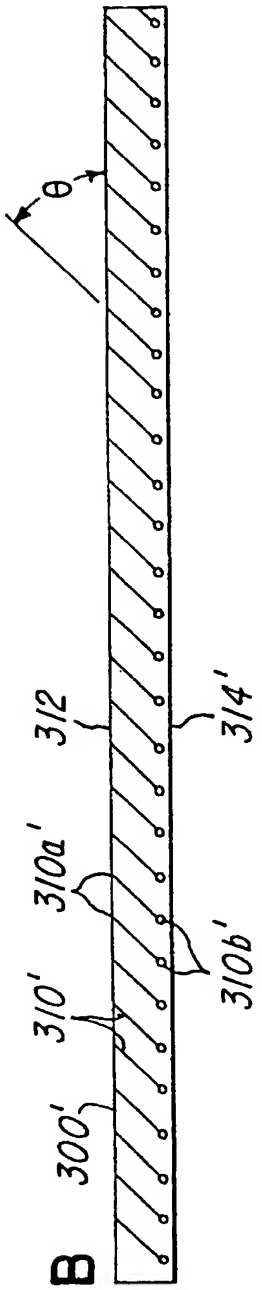


FIG-21B

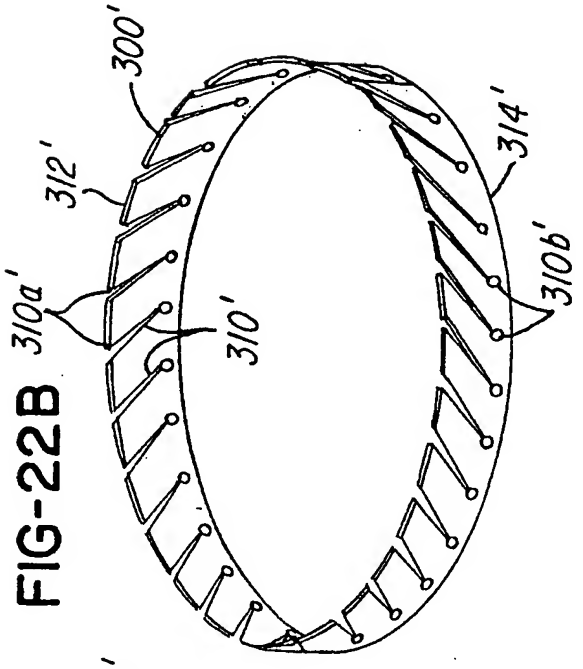


FIG-22B

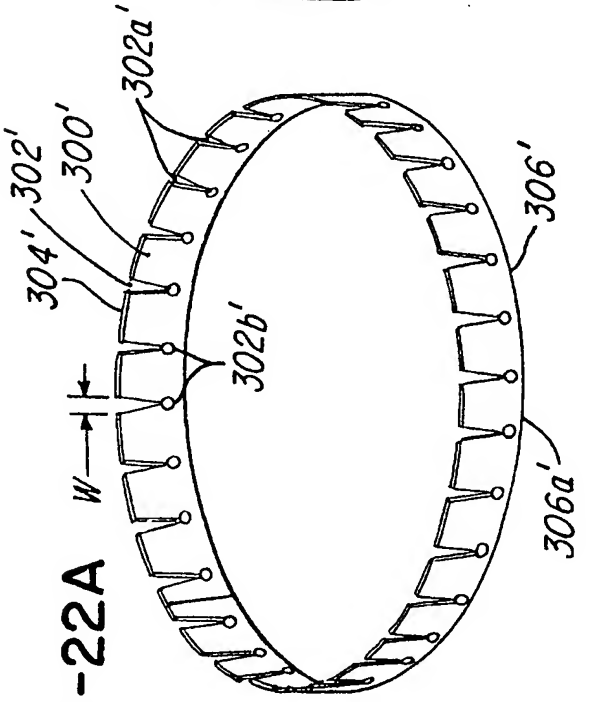


FIG-22A

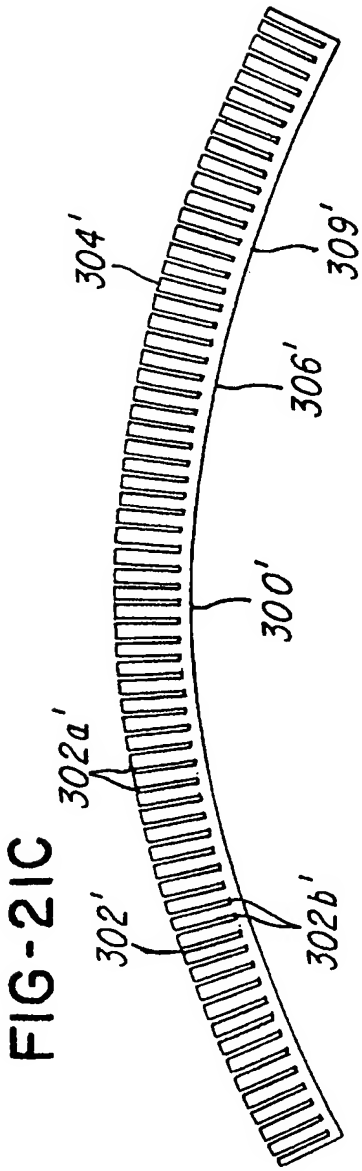
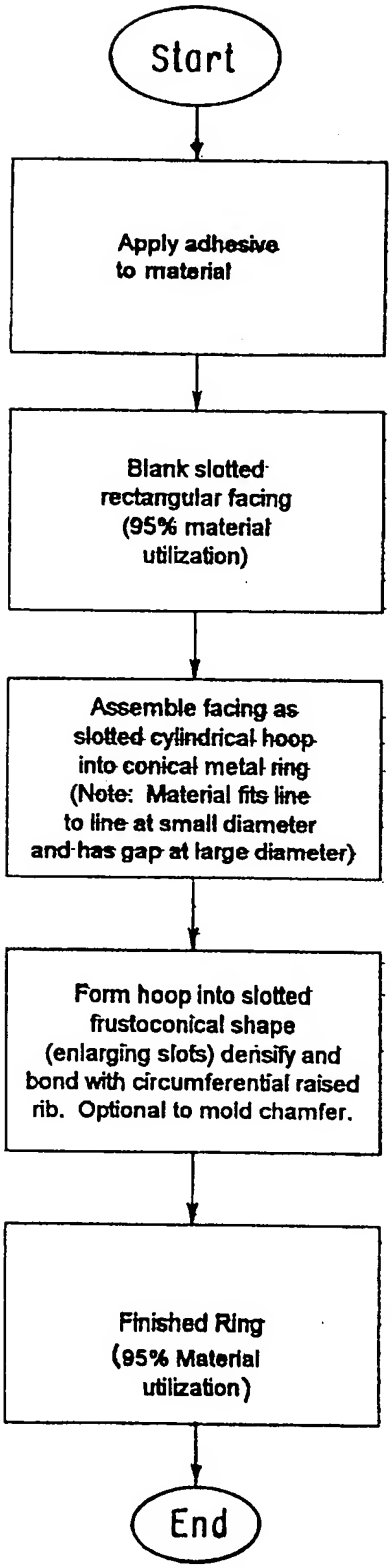


FIG-21C

FIG-23


Start
Apply adhesive to material
Blank slotted rectangular facing (95% material utilization)
Assemble facing as slotted cylindrical hoop into conical metal ring (Note: Material fits line to line at small diameter and has gap at large diameter)
Form hoop into slotted frustoconical shape (enlarging slots) densify and bond with circumferential raised rib. Optional to mold chamfer.
Finished Ring (95% Material utilization)
End

INTERNATIONAL SEARCH REPORT

Inter...onal Application No
PCT/US 98/27645

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16D69/04 F16D23/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 105 522 A (GRAMBERGER) 21 April 1992 see column 3, line 17 - column 4, line 16; figures 1-6	1
A	US 4 770 283 A (PÜTZ) 13 September 1988 see column 6, line 16 - line 22; figures 9-12	1
A	DE 37 05 657 A (ZWN) 1 September 1988 see column 5, line 5 - line 12; figures 4-6	1
A	CH 312 771 A (DEMAG-ZUG) 14 April 1956 see page 2, line 6 - line 65; figures 1-5	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 April 1999	03/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Baldwin, D

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter... .onal Application No
PCT/US 98/27645

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